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Overview of ISS US Fire Detection and Suppression System

6/25/01

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Outline

- Intro to Fire Detection and Suppression (FDS)
- Description of (FDS) Subsystems
 - Portable Fire Extinguishers (PFE)
 - PFE Testing
 - Smoke Detectors (SD)
 - Ventilation and Air Monitoring/Supply Systems
 - Portable Breathing Apparatus (PBA)
- FDS System Component Location and Status
- FDS System Capabilities

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Outline (cont.)

- FDS Automatic and Manual Response
- Post Fire Atmosphere Restoration and Air Quality Assessment
- FDS Research Needs

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Intro to FDS on ISS

- Fire Detection and Suppression (FDS) includes:
 - Detection of smoke
 - Isolation of fires
 - The means to extinguish fires
 - The means to recover from fires

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Portable Fire Extinguisher (PFE)



PFE w/Cover (config. on orbit)

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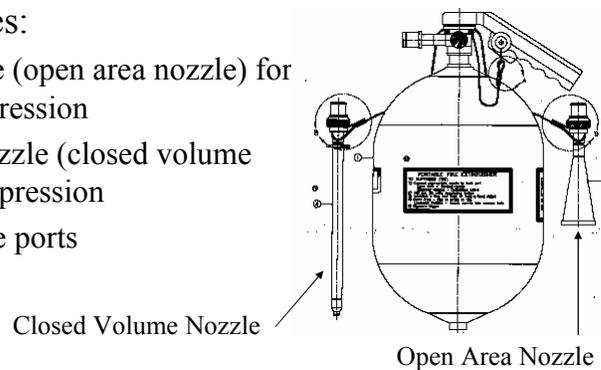
PFE w/o Cover

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Portable Fire Extinguisher (PFE)

- PFE Characteristics
 - Contains 6 lbs CO₂ at 850psi
 - Discharges in 45 sec.
 - Has two nozzles:
 - Conical Nozzle (open area nozzle) for open area suppression
 - Cylindrical Nozzle (closed volume nozzle) for suppression in closeout fire ports



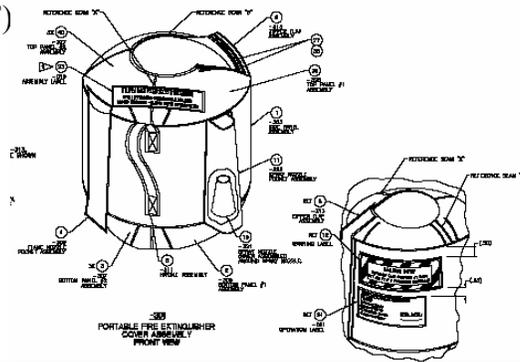
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PFE Cover

- PFE Cover Characteristics
 - Made of Nomex
 - Fits snugly to PFE
 - Keeps PFE within allowable touch temp. limits during discharge (w/o Cover, PFE reaches 0 deg. F and nozzle -32 deg. F)

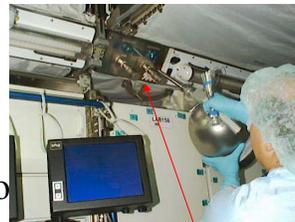


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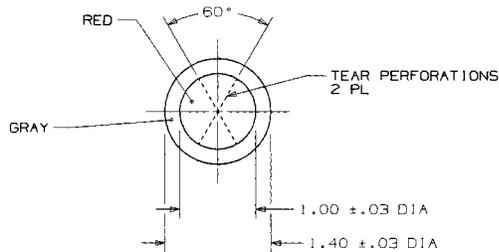
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Fire Suppression Ports

- 1" or 0.5" diameter perforated access ports in racks and standoffs for the cylindrical nozzle (enclosed area nozzle) to suppress fires
- O₂ concentration in a rack is reduced to < 10.5% within 1 min of suppression.



Suppression port nozzle inserted into suppression port



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Fire Suppression Testing

- Enclosed Volume Tests (cylindrical nozzle)
 - All CO₂ sensors show > 50% concentration for volumes 60ft³ or less
 - Good mix in enclosed volumes
- Open Volume Tests (conical nozzle)
 - Fire is suppressed by a combination of blowing the fire out (3 lb mass in first 10 sec) and supplying CO₂.

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Smoke Detector



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Smoke Detector

- **Photoelectric Smoke Detector**

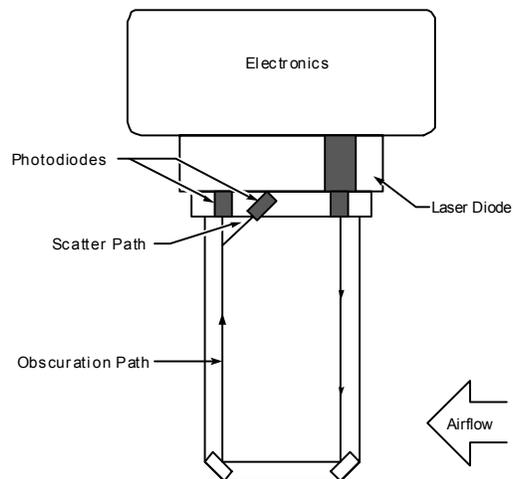
- Based on smoke particles scattering a light beam
- Light from a laser source is reflected by mirrors back to a photodiode (obscuration).
- Scattered light is measured by a second photodiode (scattering)
- Alarms are based on the voltage level generated by the scattering photodiode.

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Smoke Detector Principle



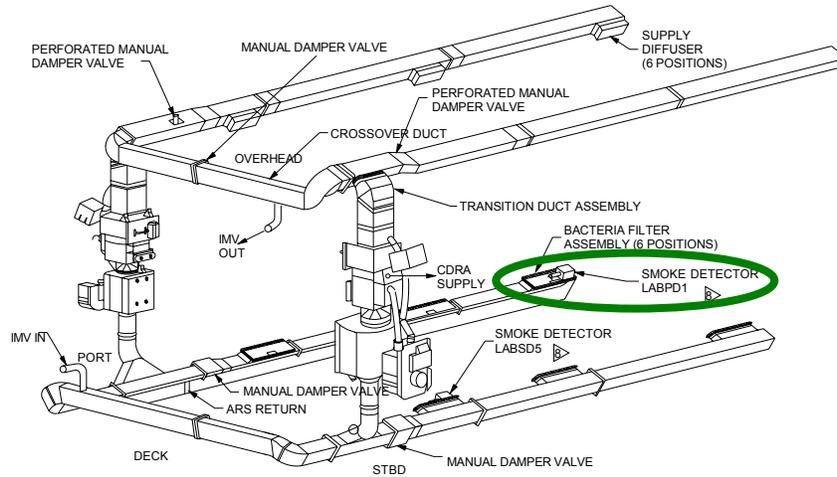
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Smoke Detectors in Ventilation

- Smoke Detectors are located on the ventilation filter intake ducts.



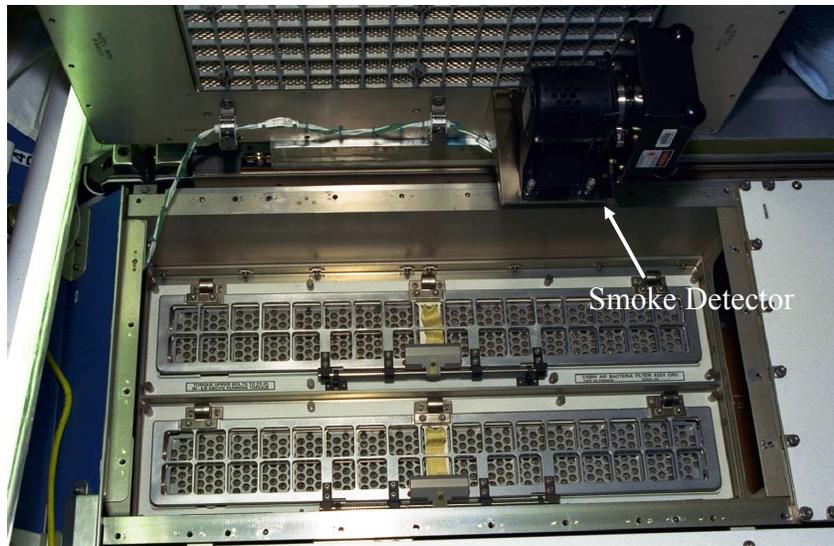
Lab Cabin Air Temperature and Humidity Control Assembly with Smoke Detectors

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Smoke Detectors in Ventilation



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Air Monitoring/Supply System

- Air components/concentrations are monitored by the Major Constituent Analyzer (MCA) in the LAB.
 - Air samples are taken from each module and routed to the sensor (mass spec.) in the MCA.
 - MCA gives percent compositions. (Typical O₂ levels on ISS are slightly less than 24%.)
- Metabolic O₂ and N₂ are supplied from Orbiter, Service Module, and Progress

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Total and Oxygen Partial Pressure Control Not In Campout Mode

- Pressure control when Not in Campout Mode (nominal) is done with closed-loop control
 - Total Pressure
 - The PCPs will be taking constant (1 Hz) total pressures
 - If the total pressure drops below 14.25 psia the Nitrogen Isolation Valve in the primary PCP will open
 - When the total pressure \geq 14.3 psia the Nitrogen Isolation Valve in the primary PCP will close
 - Oxygen Partial Pressure
 - The MCA will be making constant readings of the Station atmosphere
 - If the oxygen partial pressure drops below 3.00 psia the Oxygen Isolation Valve in the primary PCP will be opened
 - When the oxygen partial pressure \geq 3.05 psia the Oxygen Isolation Valve in the primary PCP will close

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Total and Oxygen Partial Pressure Control In Campout Mode

- While in Campout Mode, the ppO₂ in the Airlock will be controlled by the following:
 - If ppO₂ < 2.7 psia in the Airlock, the Airlock PCA will open the PCP OIV for 4 minutes +/- 10 seconds
 - If the ppO₂ > 2.85 psia in the Airlock, the Airlock PCA will open the PCP NIV for 2 minutes +/- 2 seconds
 - If either the PCP NIV or OIV was opened, wait 11 minutes after the valve closes
 - Repeat
- Total pressure control is via manual operation of the Depress Pump
- The rest of Station will continue to control total and oxygen partial pressures in the standard method

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Portable Breathing Apparatus (PBA)



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Portable Breathing Apparatus (PBA)

- PBA is composed of:
 - Mask
 - 15 minute O₂ bottle
 - 30' hose
- Provides O₂ to crew in emergency situations
 - Post-fire clean-up
 - Environmental contamination
 - Depressurization

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FDS System Component Location

- Node 1 – 2 area Smoke Detectors (SD), 1 (PBA), 1 (PFE)
 - Currently on orbit
 - PFE and PBA are nominal (have not been used)
 - SD#1 is powered, enabled, and nominal
 - SD#2 is powered and disabled
- Lab – 2 area SD, 2 system rack SD (AR rack, CHeCS rack), up to 13 experiment rack SD (3 experiment rack SD at 7A), 2 PBA, 2 PFE
 - Currently on orbit
 - PFEs and PBAs are nominal (have not been used)
 - 4 SDs (2 area and 2 rack) are powered, enabled, and nominal
 - 1 payload SD is powered, enabled, and nominal
 - 2 payload SDs operate intermittently based on payload operations

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FDS System Component Location

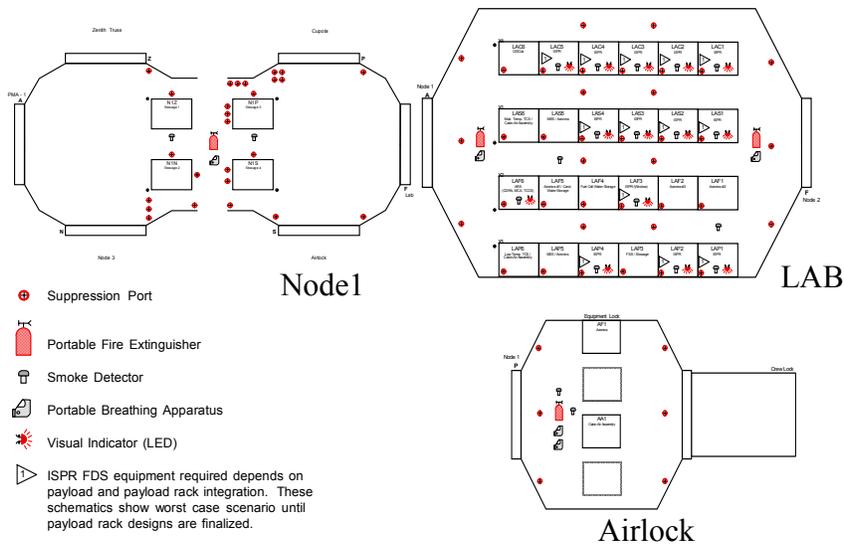
- A/L – 1 area SD, 1 duct SD, 2 Pre-breathe Hose Assemblies (PHA), 3 O2 bottles, 1 PHA spares kit, 1 PFE
- MPLM – 1 duct SD, 1 PFE, 1 PBA (PBA & PFE stored in Node1 when MPLM is not attached)

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FDS System Component Location



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FDS System Capabilities

- Node 1, Lab, A/L, & MPLM FDS
 - Fire emergency alarm received if any single SD FIRE status flag is set equal to “FIRE”
 - Scatter must exceed the fire threshold two consecutive times, the detector then initiates an active Built In Test (BIT), and the scatter must still be exceeding the threshold after the BIT to set the status flag equal to “FIRE.”
 - Location may be determined by laptop.

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FDS Automatic and Manual Response

(Overview)

- In case of fire or smoke
 - The crew can manually push the fire alarm or the Smoke Detectors can automatically initiate the fire alarm to perform the following functions:
 - 1) Remove power to racks-to isolate ignition sources
 - 2) Isolate module by shutting off ventilation (close IMV valves, sample delivery systems, cabin fans)-to stop air flow within module and exchange between modules
 - 3) Inhibit introduction of O₂ and N₂ into module (inhibit pressure control assembly in LAB)

Crew can use PFE at their discretion

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Post Fire Atmosphere Restoration

- Gaseous Contaminants removed by the following:
 - **SM - Micropurification Unit(БМП)**
 - Removes 19 different gaseous contaminants using a catalytic oxidizer (ambient) and expendable & regenerative charcoal beds.
 - **FGB - Harmful Impurities Filter (ФВП)**
 - Removes gaseous trace impurities (particles of 0.5 to 300 μ m to a level of 0.15 mg/m³).
 - **Lab - Trace Contaminant Control Subsystem (TCCS)**
 - Removes gaseous contaminants using a catalytic oxidizer (400°C) and expendable sorbent and charcoal beds. Sorbent contains LiOH which can remove acid gases.

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Post Fire Atmosphere Restoration

- **Carbon Dioxide Removal Assembly (CDRA)**
 - Removes CO₂ from the atmosphere that was discharged from the PFE
- **Extra charcoal air filters**
 - Scrub the environment and contain 2% Pt for CO removal.
- **CO₂ Removal Kit (CRK)**
 - Consists of a portable fan assembly with a LiOH cartridge adapter.
 - Can be used with LiOH or ATCO catalyst canister for CO₂ or CO removal
- **Venting module to space**
 - Only in worst case scenario

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Post Fire Air Quality Assessment

- Air quality analysis done with the following equipment:
 - Compound-Specific Analyzer for Combustion Products (CSA-CP)
 - Carbon Dioxide Monitoring Kit (CDMK)
- Final analysis using Draeger detector tubes
- Atmospheric sampling, using GSC and AK-1 air sampling assemblies, for delivery to ground.

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FDS Research Needs

- Data to support suppressant selection
 - Suppressant
 - Effective
 - Not harm ECLSS or other equipment
 - No/low toxicity
 - Not require extensive clean up
- Microgravity research on suppression of fire
 - Experiments needed on fabrics and items on orbit likely to burn

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??Questions??



Contact Info.

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